



**Infectious Disease Epidemiology Section**  
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## **ANTHRAX**

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Anthrax is an acute infectious disease caused by the bacterium *Bacillus anthracis*. *Bacillus anthracis* is a gram-positive, spore-forming bacillus that can cause acute infection in both animals and humans. It is primarily a disease of herbivores, which acquire infection after coming into contact with soil-borne spores.

There is an increasing concern over the possibility of terrorist use of biological agents to threaten either military or civilian populations. Anthrax spores were weaponized by several countries starting in the 1950's. Anthrax bacterium is easy to cultivate and spore production is readily induced. Spores are highly resistant to heat, sunlight and disinfections – properties which could be advantageous when choosing a bacterial weapon. Although production of mass quantities of anthrax is relatively easy, weaponizing to obtain stable microscopic particle requires skills and experience that are difficult to obtain outside a well organized bioweapon program.

### **Epidemiology**

Anthrax is a zoonotic disease, one which usually occurs in animals but can be transmitted to humans. Humans can become infected following contact with infected animals or their contaminated products.

Reservoir: *B.anthraxis* spores can live in the soil for 40 years or more. Spore forms of the organism are found in infected soil and have been found in soil in rural farming regions in several areas of the United States. Spores are found in hides, carcasses, hair, wool, bone meal, and other animal by-products of domesticated and wild animals, such as goats, sheep, cattle, swine, horses, buffalo, or deer. Imported dolls and toys decorated with infected hair or hides have been a source of infection. Infected animals are rare in the U.S.

Transmission: There are three forms of anthrax: cutaneous (skin), inhalation, and gastro-intestinal each caused by different transmission modes:

- Cutaneous anthrax, which occurs principally in agricultural and industrial employees, results from contact with infected animals, carcasses, hair (especially goat), wool, hides, and soil.
- Pulmonary (inhalation) anthrax results from inhalation of spores, coming from infected animal skins and hair. Although the soil in farms with infected animals contains anthrax spores, dust particles from these soil have not caused inhalational anthrax among farmers.
- Gastrointestinal anthrax results from ingestion of contaminated meat.
- No form of anthrax is transmitted from person to person.

Only two cases have been reported in Louisiana since 1960. Those two cases were reported in 1971 from Ascension Parish. Two men, both veterinarians, were involved in an investigation of 485 animal deaths from anthrax in Ascension Parish.

The incubation period for anthrax ranges from 2 to 60 days.

## Clinical Description

### Cutaneous anthrax

The spores deposited under the skin germinate and multiply. They produce a toxin responsible for the lesions and tissue necrosis. If the bacilli are picked up by the lymphatic system, the infections may spread. These lesions occur in the exposed parts of the body: arms, then face and neck. A pruritic papule develops in a vesicle in a few days. The vesicle turns into an ulcer. Several vesicles may coalesce to form a ring. The center becomes necrotic while the vesicles rupture. The lesion dries up and an eschar forms. Lesions are 1-3 cm in diameter. It is accompanied by regional lymphadenitis and mild systemic symptoms. Antibiotic therapy does not change the evolution of the lesion.

Malignant edema is a severe form of infection with large bullae, spreading edema, induration, chills and fever. Lesions of the face may become quite severe with necrosis of the eyelids.

### Inhalation anthrax

The spores must be deposited in the alveoli where they are phagocytized by macrophages. They germinate and produce their toxin which causes necrosis and hemorrhage in the lungs. The pathological picture is hemorrhagic mediastinitis with destruction of the normal architecture.

The initial phase is a non specific illness, flu-like, with mild fever, dry cough, myalgia and chest pain. After 2-3 days a severe respiratory distress develops with severe dyspnea, cyanosis, high fever, pleural effusion, and in some cases, edema of the chest and neck. The only characteristic sign on the chest Xray is the widening of the mediastinum. Death can occur within 24 hours after onset of the severe phase. Inhalation anthrax is almost always fatal.

### Gastrointestinal anthrax

Disease affecting the distal gastrointestinal tract results in nausea, anorexia and fever followed by abdominal pain, ascites and bloody stool. Symptoms may be so acute as to be mistaken for an “acute abdomen”. Toxemia will cause death in a few days. The case fatality rate among reported cases ranges from 25%-60%.

Other: Meningitis, septicemia are rare complications of anthrax.

## Laboratory

*B.anthraxis* is a gram positive bacillus with a typical microscopic appearance. It forms long chains of large rectangular bacilli (each bacillus being 3 to 10 µ long and 1 µ wide) referred to as “boxcars”. Spore stains show central or paracentral spores. It grows on ordinary media in 12 hrs to form grayish white convex colonies.

The diagnosis of anthrax relies in the identification of the bacilli. The bacilli are found easily in the vesicles and the pus. Their morphology and culture are easily recognized. The diagnosis of inhalation anthrax is more difficult if the infection is not suspected on epidemiologic information.

*Bacillus anthracis* is detected in capsule–stained (McFadyean–stained) smears and readily isolated in pure culture on blood or nutrient agar plates. With occasional exceptions, it is generally easy to identify *B.anthraxis* and to distinguish it from other *Bacillus* species, including *B.cereus*. For all practical purposes, an isolate with the characteristic colonial morphology on nutrient or blood agar (matt appearance, fairly flat, similar to *B.cereus* but generally rather smaller, more tacky, white or grey–white on blood agar, and often having curly tailing at the edges), and which is non–hemolytic or only weakly

hemolytic, non-motile, sensitive to the gamma-phage and penicillin, and able to produce the capsule in blood or on anaerobic culture on bicarbonate media is *B.anthraxis*.

Blood culture contamination rates of 5 percent are not uncommon. In some institutions, contamination rates have run as high as 10 percent, which is not acceptable. Three percent is generally considered achievable. The majority of blood culture contaminants are *Staphylococcus* sp., usually coagulase-negative. *Bacillus* spp. are probably the second most common contaminant. Most of these would be *B.cereus*.

The OPH laboratory uses PCR testing to identify anthrax in environmental samples. Processing the tests takes approximately 2 to 3 hours. A positive PCR test provides a strong suspicion for the presence of *B.anthraxis* but still needs culture for full confirmation.

Currently accepted as the best serological procedure is the ELISA in microtitre plates coated with the Protective Antigen (PA) component of the anthrax toxin in high pH (9.5) carbonate coating buffer. The toxin antigens appear to be truly specific for *B. anthracis*, although there is at present no commercial source of these. This tends to mean that anthrax serology is currently confined to a few specialist laboratories. Various versions of the ELISA exist and can be found in standard laboratory manuals; any version will do for anthrax serology.

## **Treatment**

Natural B anthracis strains are resistant to extended-spectrum cephalosporins. Erythromycin, chloramphenicol, clindamycin, first-generation cephalosporins, aminoglycosides, and vancomycin are effective in vitro. The preferred treatment for anthrax is:

- IV penicillin G, 4 million units every 4 to 6 hours, for 10 days
- Some suggest addition of streptomycin (or gentamicin)
- Ciprofloxacin, 400 mg IV every 8 to 12 hours,
- Doxycycline, 200 mg IV and then 100 mg IV every 8 to 12 hours

## **Surveillance**

Anthrax is a reportable condition. It should be reported immediately by phone because of concern about bioterrorism as a cause.

## **Case Definition**

A case of anthrax is defined as a clinically compatible case that is laboratory confirmed. The illness has an acute onset and can be characterized by several distinct clinical forms including:

1. Cutaneous: A skin lesion that evolves during a period of two to six days from a papule, through a vesicular stage, to a depressed black eschar
2. Inhalation: A brief prodrome resembling a mild upper respiratory illness, followed by development of hypoxia and dyspnea, with radiographic evidence of mediastinal widening
3. Intestinal: Severe abdominal distress followed by fever and signs of septicemia
4. Oropharyngeal: Mucosal lesion in the oral cavity or oropharynx, cervical adenopathy and edema, and fever.

## Case investigation

The purpose of investigation is

- to identify and confirm cases,
- to trace the source of infection with particular attention to the possibility of bioterrorism,
- to search for other exposed individuals,
- to assist the U. S. Department of Agriculture (by source identification) with the eradication of anthrax in cattle, swine, and other animals.

The public health and medical response to the threat or use of biological weapons may be different from the epidemiologic case investigation for isolated anthrax cases. This manual describes the investigation of anthrax resulting from natural causes. If a bioterrorism event is suspected, call the Infectious Disease Epidemiology section or after hours the section's numbers listed above. Handling of a suspected bioterrorism is discussed in the Infectious Disease Epidemiology section "Bioterrorism Epidemiologic Surveillance and Response Manual".

- Upon receipt of a report of anthrax immediately contact the Infectious Disease Epidemiology Section.
- Contact the physician and/or hospital to confirm the diagnosis.
- Obtain clinical details.
- Ask if any anthrax specific laboratory tests were performed. Request that an isolate be submitted to the state lab for confirmation.
- Attempt to identify
  - History of exposure to infected animals or animal products. Cases have occurred in industrial settings, probably related to the processing of batches of highly contaminated imported animal fibers, particularly goat hair.
  - History of travel because anthrax remains a problem in developing countries, animal products imported from these areas continue to pose a risk.
  - Occupation: occasional cases occur in industrial settings, related to the processing of batches of highly contaminated imported animal fibers, particularly goat hair.
  - Farming: skinning and cutting meat of an animal alleged to have shown symptoms of anthrax, eating contaminated meat, and handling contaminated meat in the process of selling it, and caring for a sick animal.

## Post-Exposure prophylaxis (PEP)

Antibiotic prophylaxis immediately after exposure suppresses clinical disease. Effectiveness depends on how early the PEP was instituted.

IV penicillin G, 4 million units every 4 to 6 hours, for 10 days.

Some suggest addition of streptomycin (or gentamicin).

Ciprofloxacin, 400 mg IV every 8 to 12 hours.

Doxycycline, 200 mg IV and then 100 mg IV every 8 to 12 hours.

## Indications for prophylaxis are:

### •Consumption of contaminated meat

No evidence supports the existence of persistent spores associated with gastrointestinal forms of the disease; however, if the meat consumed is highly contaminated with *B.anthraxis*, infection may occur. Although possible interventions range from close observation to antibiotics alone to antibiotics with vaccination, because of the fatality for anthrax infection, management consists of an extended course of ciprofloxacin combined with administration of anthrax vaccine.

Federally-inspected and state-inspected animal processing facilities are required to perform intensive cleaning after contact with anthrax-infected carcasses ; veterinary inspection is not provided at custom meat processors. Slaughter house workers who may be exposed to an anthrax-contaminated carcass should receive medical evaluation for symptoms and for possible treatment

- Exposure to live spores: caring for a sick animal, exposure to fur, material woven with contaminated fibers.

- Post attack intervention

Oral fluoroquinolones are the drugs of choice for adults, including pregnant women. If fluoroquinolones are not available or are contraindicated, doxycycline is acceptable. Children should receive prophylaxis with oral ciprofloxacin.

Drug	Adults	Children
Oral fluoroquinolones		
Ciprofloxacin	500 mg bid	20-30 mg/kg /d divided q 12hrs
Levofloxacin	500 mg once daily	Not recommended
Ofloxacin	400 mg bid	Not recommended
If fluoroquinolones are not available or are contraindicated		
Doxycycline	100 mg bid	5 mg /kg /day divided q 12 hr

- Prophylaxis should continue until exposure to *B.anthraxis* has been excluded. If exposure is confirmed, prophylaxis should continue for 4 weeks and until three doses of vaccine have been administered or for 8 weeks if vaccine is not available.
- Use of tetracyclines and fluoroquinolones in children has well-known adverse effects; these risks must be weighed carefully against the risk for developing life-threatening disease. If a release of *B.anthraxis* is confirmed, children should receive oral amoxicillin 40 mg per kg of body mass per day divided every 8 hours (not to exceed 500 mg three times daily) as soon as penicillin susceptibility of the organism has been confirmed.

## Immunization

Immunization of high-risk persons such as veterinarians and others handling potentially contaminated carcasses or industrial raw materials.

Postexposure vaccination with an inactivated, cell-free anthrax vaccine (Bioport Corporation, formerly Michigan Biologic Products Institute) is indicated in conjunction with chemoprophylaxis following a proven biologic incident. Postexposure vaccination consists of three injections: as soon as possible after exposure and at 2 and 4 weeks after exposure. Anthrax vaccine can be requested through CDC. Although this vaccine is now being administered routinely to U.S. military personnel, routine vaccination of civilian populations is not recommended. This vaccine has not been evaluated for safety and efficacy in children aged less than 18 years or adults aged greater than 60 years.

## Prevention

### Hospital precaution and isolation:

Standard precautions should be used for the duration of the illness for both cutaneous and inhalation anthrax. Anthrax is not transmitted from person to person. Therefore neither droplet nor airborne precautions are indicated.

Contaminated dressings and bedclothes should be burned or steam-sterilized to destroy spores.

## Prevention

Occupational anthrax: Disinfection of contaminated animal skins and hairs, industrial hygiene progress in reducing exposure of workers, dust-collecting equipment during the initial processing cycle and the institution of effective environmental clean-up procedures have reduced the risk in industrial settings. Employees should be educated about the disease and the recommendations for working in a contaminated environment and for reducing the risk of developing the disease. Medical consultation services should be available to employees. Adequate clean-up facilities and clothes-changing areas should be available so that workers do not wear contaminated clothes home.

Foodborne anthrax: Gastrointestinal anthrax can be prevented by forbidding the sale for consumption of meat from sick animals or animals that have died from disease. Depending on the circumstances, it may be important to alert persons who may come in contact with contaminated meat about the disease and about the need to cook all meats thoroughly.

Agricultural anthrax: Control of the disease in humans ultimately depends on control of the disease in animals. Effective animal vaccines are available, and all cases should be reported to state veterinary authorities. Management of anthrax in livestock should include

- quarantine of the herd;
- removal of the herd from the contaminated pasture, if possible;
- vaccination of healthy livestock: Immunization of animals repeated every year is effective in eradicating the disease. Immunizations of exposed individuals is useful in preventing human cases, but is rarely done on a large scale;
- treatment of symptomatic livestock; and
- disposal of infected carcasses, preferably by burning. Bedding and other material found around the carcass (e.g., soil) should be incinerated with the carcass and buried.

Veterinarians notified of sudden death in an animal or of an animal unable to rise should consider anthrax as a diagnosis, especially in areas where anthrax is endemic. However the potential risk for animal anthrax exists in all areas of the United States. Vaccination of livestock in areas where anthrax is endemic is the most effective method of prevention in animals and humans. Cases of anthrax in animals and cases of suspected human exposure should be reported immediately to the the Louisianan Department of Health at the number listed above.

Laboratory anthrax: spills, splashes, accidents have caused cases of anthrax in the laboratories.

Chlorine solutions. Commercially-prepared hypochlorite frequently takes the form of stock solutions having approximately 10% available chlorine (100 000 ppm). Thus, what is familiarly referred to in laboratories as "10% hypochlorite solutions" is a 1:10 dilution of the stock solution containing 10 000 ppm available chlorine.

Chlorine solutions are not highly stable and stock solutions should be titrated periodically to ensure that the correct level of available chlorine is. Since stability is affected by concentration (and also by temperature and pH), subsequent dilutions should be made only as needed and these solutions should be changed frequently (at least weekly). It should be remembered that chlorine solutions corrode metals and perish rubber and that chlorine is rapidly neutralized by organic materials, including wood (as in wooden benches), soil, or specimens of blood or tissues.

Simple chlorine solutions are slow to kill spores. The sporicidal rate can be increased by using 50% methanol or ethanol to make the dilutions of the stock solution.

Rapid turnover items such as pipettes, disposable loops, microscope slides, sampling spoons, etc., should be immersed overnight in hypochlorite solutions with 10 000 ppm available chlorine and then transferred to an autoclave bin or bag for autoclaving, or to a bag for incineration.

Benches should be wiped down after use with hypochlorite solutions containing 10 000 ppm available chlorine. Because of their neutralising effect on chlorine, wooden benches should be replaced by more suitable materials or covered with plastic or laminated sheeting, or with a proprietary covering designed for the purpose, such as Benchcote T (Whatman International Ltd, Maidstone, UK).

Spills and splashes on surfaces. Some thought must be given to the nature of the material spilled. For example, freshly growing *B. anthracis* cultures will have few, if any, spores and these will be incompletely dormant and more susceptible to disinfection procedures than, at the opposite extreme, purposely prepared spore suspensions.

In general, spills and splashes on floor, bench or apparatus should be flooded with hypochlorite solution containing 10 000 ppm available chlorine and vertical surfaces should be washed or wiped down thoroughly with cloths soaked in this solution (*the operator should wear gloves and safety spectacles while doing this*). Spills and splashes from fresh cultures can be mopped up with towelling after 5 minutes; the towelling should be placed in an autoclave bin or bag and autoclaved or in a bag for incineration. Spills or splashes of spore suspensions should be left for 30–60 minutes before mopping up unless the area can be sealed off and fumigated, in which case mopping up can be done after a few minutes and fumigation carried out immediately.

An alternative approach is to cover the contaminated area with absorbent material and wet this with an excess of disinfectant. Solutions of 10% formalin, 4% glutaraldehyde or 1% peracetic acid may be more appropriate than hypochlorite, but the choice must be weighed against the greater personal protection needed when using these.